

NEWS



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546

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FOR RELEASE: SUNDAY  
January 26, 1969

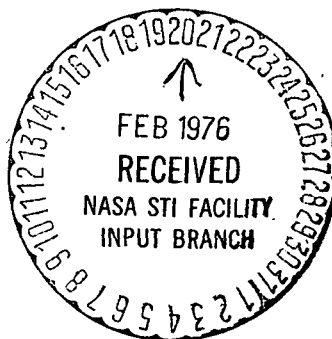
RELEASE NO: 69-14

PROJECT: ISIS-A

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(NASA-News-Release-69-14) : ISIS-A LAUNCH  
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**NEWS**



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546

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January 22, 1969

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CORRECTION TO ISIS-A PRESS KIT

Paragraph 2, first page of Press Kit, ISIS-A  
(NASA Release 69-14) should be corrected to read as follows:

ISIS-A (International Satellite for Ionospheric  
Studies) is the third Canadian ionospheric satellite to  
be launched in a cooperative Canadian-U.S. effort. It  
will continue, etc.

-end-

1/22/69

# NEWS



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WASHINGTON, D.C. 20546

TELS. WO 2-4155  
WO 3-6925

**FOR RELEASE: SUNDAY**  
**January 26, 1969**

RELEASE NO: 69-14

## ISIS-A LAUNCH SCHEDULED

The joint Canadian-United States program of ionospheric research will move into a new stage with the launching of the Canadian satellite, ISIS-A, on a National Aeronautics and Space Administration Delta rocket from the Western Test Range, Lompoc, Calif. no earlier than Jan. 29.

ISIS-A (International Satellite for Ionospheric Studies) is the third Canadian ionospheric satellite and the second of five satellites in a cooperative Canadian-U.S. effort. It will continue the study of the ionosphere from above (topside sounding) successfully begun with the Alouette I satellite.

More information on the nature and behavior of the ionosphere is needed to improve long-range radio transmissions which are possible only through use of the ionosphere to reflect them back to Earth.

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Measurements of the ionosphere from above were begun with the Canadian satellite Alouette I launched Sept. 29, 1962 under a cooperative agreement between the Canadian Defense Research Board (DRB) and NASA.

Alouette I, designed, engineered and constructed in Canada, established a longevity record and continues to return useful data after more than six years in orbit.

The success of Alouette I led the U.S. and Canada to agree to an expanded cooperative program of ionospheric studies to extend through an entire solar cycle.

The ISIS series began with ISIS-X which was launched Nov. 29, 1965 and consisted of the Canadian satellite Alouette II and the NASA Explorer XXXI (Direct Measurement Explorer). Both satellites provided excellent data and continue to transmit.

ISIS-A carries five Canadian and five United States experiments. The satellite will be placed in a near-polar highly elliptical orbit ranging from a high point of 2,200 statute miles (about 3,500 km) to a low point of 300 miles (about 565 km). It weighs 532 pounds and has a planned orbital period of 128 minutes.

ISIS-B and C are scheduled to be launched at about one-year intervals after ISIS-A.

The ISIS program is conducted jointly by NASA and the Canadian Defence Research Board with each agency defraying the costs of its own portions of the program.

Defence Research Telecommunications Establishment (DRTE) Ottawa, Ontario, a part of the DRB, is responsible for management of the Canadian portion of the program and is the satellite design authority. NASA's Goddard Space Flight Center, Greenbelt, Md., is responsible for the U.S. portion of the program. The Kennedy Space Center's Western Test Range, Lompoc, Calif. will provide pre-launch and launch support.

The NASA STADAN tracking network, operated by Goddard Space Flight Center, will track the ISIS satellite and acquire telemetry data. This network will be augmented by stations operated by the Canadian government, by France, the United Kingdom and Norway and by ESSA for the U.S. It is expected that stations in Antarctica, Japan, Australia and India will augment this effort as the program evolves.

Scientists in Australia, India, Hong Kong, Japan, France, and United Kingdom and Norway are actively participating with their Canadian and U.S. counterparts in the ISIS Working Group which recommends topside ionospheric research activities using the satellites in the ISIS program which often relate to similar ground-based activities carried out in a number of countries around the world.

After evaluation by the principal investigators, scientific results will be made available to the world scientific community.

ISIS-A prime contractor is the RCA Victor Co., Ltd., Montreal, Canada, under supervision of the DRTE. The Delta rocket is built by the McDonnell Douglas Corp., Santa Monica, Calif.

(END OF GENERAL RELEASE: BACKGROUND INFORMATION FOLLOWS)

## THE IONOSPHERE

Scientists engaged in the ISIS-A program are concerned primarily with the upper latitude regions of the ionosphere. Some of the radiation directed from the Sun towards the Earth is absorbed in the ionosphere which extends upwards from approximately 35 miles above Earth. During this absorption process, neutral air particles are split into electrically-charged ions and electrons. They create, in effect, an electrical conductor with the ability to reflect radio waves from transmitters to receivers, and hence to guide these waves around the curvature of the Earth by a process of successive reflection.

When the ionosphere becomes disturbed following solar storms or other phenomena associated with the Sun, its reflecting properties are affected. Consequently, radio communications are disrupted, sometimes for long periods. Hence, there is a deep interest in studying the upper atmosphere in order to find methods of overcoming the effects of ionospheric disturbances.

An unusual feature of the polar and subpolar ionosphere stems from seasonal variations of the polar atmosphere's solar illumination -- continuous daylight in summer and continuous night during the winter. A second feature of the ionosphere at high latitudes involves effects on ionization created by charged solar particles.

The "auroral ionosphere" exhibits a wide variety of disturbed conditions. It resembles that in the temperate zones only during quiet conditions and then only on rare occasions.

Perhaps the worst ionospheric condition, from the standpoint of communications, is the so-called "polar blackout." During such occurrences, reflections cannot be obtained from the ionosphere by most ground-based ionosphere recorders (called ionosondes). Consequently, the ionograms (or records of electron plasma frequency as related to height) obtained are sometimes completely blank. Rocket flights and other experiments have shown that these polar blackouts stem from an abnormal increase in the ionization of a specific ionospheric region which is caused by solar particles. The effect on communications is a complete cessation of radio sky-wave transmissions at high frequencies due to absorption in the D-region.

"Sudden ionospheric disturbances" also cause loss of communications, producing abrupt and simultaneous radio fadeout throughout the hemisphere which may last from 10 minutes to an hour. Polar blackouts, however, are more gradual in their beginning and recovery and last for substantially longer periods -- sometimes continuously during the daylight hours for several consecutive days.

The "ionospheric storm" is another type of disturbance intensified in the auroral zones. It is characterized by a general instability of ionospheric conditions, a decrease in the maximum density of ionization and an increase in absorption. The maximum employable frequencies are much lower than normal during these periods and the restricted communications spectrum is subject to rapid fluctuations in signal intensity. An ionosphere storm is usually accompanied by a period of unusual fluctuation in terrestrial magnetic intensity.

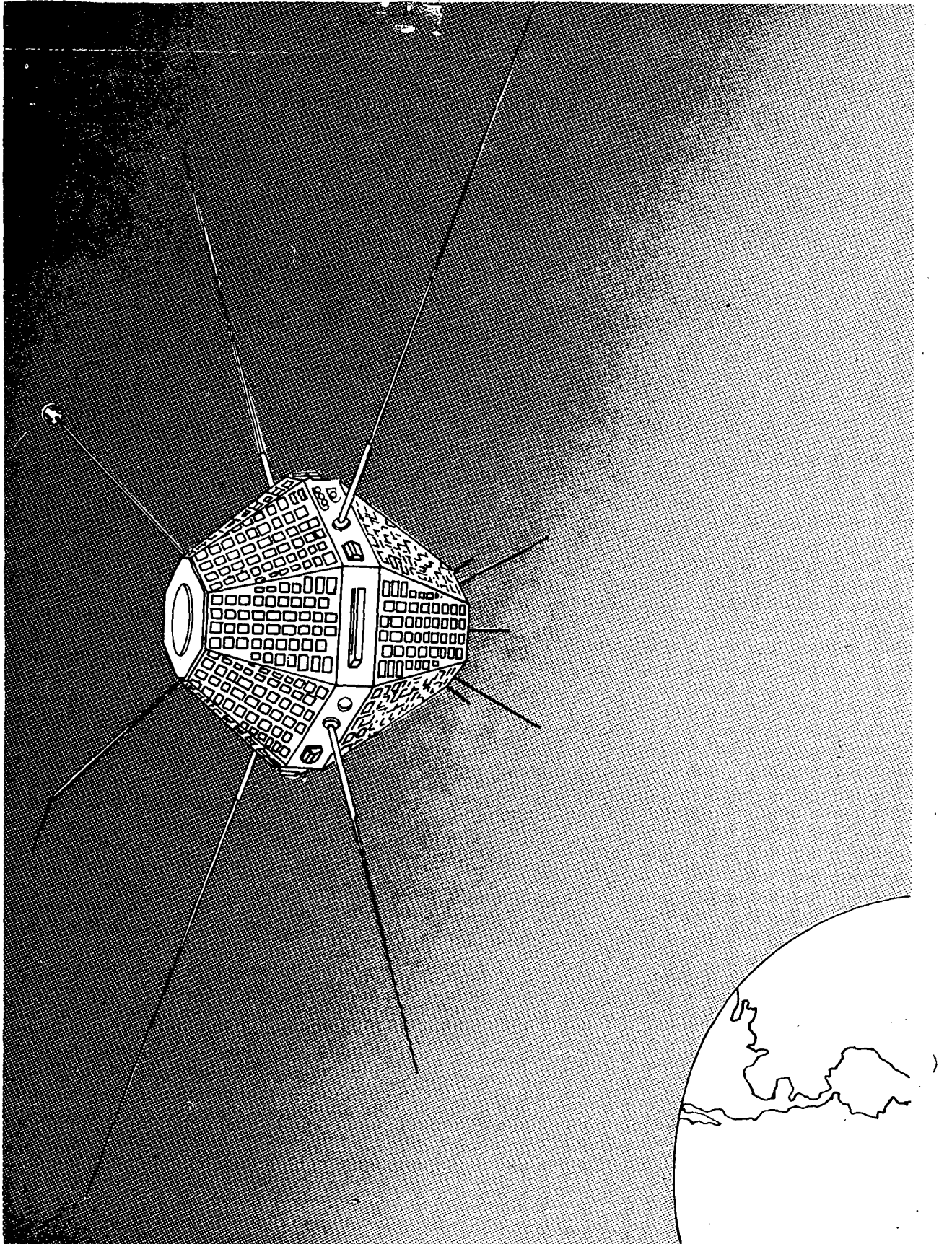
The topside satellite sounder technique (Alouette I and II, Explorer XXXI) developed under this program is the only one known that can provide worldwide electron-density profiles synoptically above the height of maximum electron density of the ionosphere. (Ground stations can only sound up to the maximum electron density.) These satellite soundings permit the investigation of the physical properties of the upper ionosphere as a function of altitude, time and geographical location.

In addition to its scientific value, increased knowledge gained about the ionosphere can be applied directly to communications and tracking operations. The importance of the ionosphere to terrestrial radio communication is well known. Predictions of ionospheric storms and disturbances are often unsatisfactory because they are based on inadequate information. Because a thorough understanding of natural phenomena is a prerequisite to their intelligent use, improved knowledge of the entire mechanism should lead to more precise forecasts.

The present prediction of maximum usable frequencies for communications purposes is based on ionosondes from ground-based ionospheric stations. This information was considered of sufficient importance to justify the establishment of about 150 ground-based ionospheric sounding stations throughout the world. This number of stations, however, still does not permit accurate worldwide mapping of the bottom-side ionosphere, and the information from each station is insufficiently detailed.

Two of the most important observations obtained by these stations are the height and density of maximum ionization in the ionosphere. Topside sounders are capable of providing this information, together with the complete electron density profile from the electron peak to the altitude of the satellite.





### THE ISIS-A SATELLITE

In ISIS-A, direct measurements will be combined with the topside sounder to measure most of the important ionospheric parameters at the same time and in the same location in space.

Heavier than its predecessor satellites Alouettes I and II, ISIS-A will weigh 532 pounds. Like its predecessors, it is spheroid in configuration. Its outside surface is covered with more than 11,000 solar cells to power the batteries within.

ISIS-A is fitted with two extendable antennas, 240 and 62 feet long, respectively, to sound or probe the upper levels of the ionosphere. Four telemetry antennas project from the base of the spacecraft to accept commands from the ground and to transmit data gathered by the satellite to ground stations. Quadraloop antennas are mounted around the satellite's equator to radiate beacon transmissions, and two antenna-like booms support probes for use in several of the onboard experiments.

The 50-inch-diameter by 42-inch-high spacecraft will be launched in an elliptical polar orbit - 300 statute miles at its nearest (perigee) and 2,200 statute miles at its farthest (apogee) points from Earth.

The satellite's 10 experiments and expanded facilities have necessitated power requirements considerable greater than those employed in its predecessors. A new feature, designed for the ISIS spacecraft series, is a spin and attitude system to control spin action in space and also to control the attitude of the spacecraft relative to the Sun and the Earth.

NASA has provided final thermal and environmental pre-launch testing facilities and associated manpower at the Goddard Space Flight Center, Greenbelt, Md.

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### ISIS-A EXPERIMENTS

ISIS-A is a more complex spacecraft than the Alouettes I and II, and shows the evolution of the program from a topside sounder to virtually an observatory class satellite. Alouette I is conducting four experiments and Alouette II has five experiments. The ten experiments carried by ISIS-A are:

#### DRTE Experiments:

- \* A swept high frequency sounder to probe the ionosphere over great distances.
- \* A fixed frequency sounder to probe the ionosphere at six specific frequencies.
- \* A radio noise experiment to measure ionospheric and extraterrestrial radio noise in the outer atmosphere.
- \* A special radio receiver for measuring the very low frequency (VLF) signals generated by lightning flashes and other natural phenomena. Artificial generation of some of these phenomena will also be attempted by a generator in the satellite. In addition, a VLF exciter will stimulate resonances in the plasma, the area in the upper atmosphere comprising many gaseous components, enveloping and in the immediate vicinity of the orbiting spacecraft.

#### NASA Experiment:

- \* A cylindrical electrostatic probe to measure the temperature and concentrations of electrons near the spacecraft.

#### National Research Council of Canada Experiment:

- \* Detectors of energetic particles to provide data which will aid in the understanding of:
  - the mechanism responsible for the production and control of the particles which populate the outer radiation zone and which sometimes precipitate into the atmosphere;
  - the related problem of entry into the Earth's magnetic field of solar and other particles, and
  - the general distortions which occur in the Earth's magnetosphere as a result of its interaction with the solar wind.

USAF Cambridge Research Laboratories Experiments:

- \* A detector (ion mass spectrometer) that identifies the types of positively charged particles in the vicinity of the satellite, such as protons, oxygen ions and helium ions, and
- \* A three-inch spherical electrostatic probe, fitted to the end of a boom that projects from the main body of the satellite, to measure the temperature numbers and density of positively charged particles (ions).

University of Western Ontario Experiment:

- \* A radio beacon whose transmissions when received at a ground station will give information about ionospheric structure and irregularities.

U.S. Southwest Center for Advanced Studies Experiment:

- \* A detector of particles with somewhat lower energies, such as the electrons that precipitate out of the upper atmosphere and cause visual auroral displays.

## DIFFERENCES FROM THE EARLIER IONOSPHERE SATELLITES

The ISIS A ionospheric sounder resembles closely that carried by Alouette II. The frequency coverage has been extended however, because the satellite will be launched into a higher orbit and later in the solar epoch. Similarly, transmitter power has also been increased.

The fixed frequency sounder is a new experiment in the ISIS series to study irregularities in the ionosphere's horizontal plane. Essentially, the difference between the two sounder experiments is that the swept frequency sounder will sample at the same frequency at intervals of about 200 kilometers or 108 nautical miles whereas the fixed frequency sounder will sample at intervals of about 0.27 kilometers or 0.14 nautical miles.

The VLF experiment will include a swept frequency transmitter to stimulate resonances among ions similar to those previously reported with electrons at higher frequencies.

Because some high latitude ionospheric phenomena appear to depend on low energy electrons, the lower energy limit of electron detection has been reduced in the energetic particle experiment from that carried in Alouette II.

More information regarding ion density and temperature will be gained from the ion probe experiment and ion masses will be determined by the ion mass spectrometer. Two instruments for this experiment will permit measurements to be taken along the satellite velocity vector at all latitudes.

The beacon designed by the University of Western Ontario will measure scintillations, particularly in the auroral zone.

ISIS-A FACILITIES

<u>Attitude Sensing</u>	3 axis magnetometer Thermistors Solar aspect sensor
<u>Attitude Control</u>	Spin maintenance and spin axis attitude control by magnetic torquing
<u>Tracking Beacon</u>	250 mW
<u>Telemetry</u>	4W FM 100 KHz bandwidth 2W PCM/PM 50 KHz bandwidth 4W 400 MHz 500 KHz bandwidth, for fast playback of tape recorder, or direct transmission of sounder or VLF experiment.
<u>Command</u>	216 possible commands Programmer: 5 commands can be stored together with their times of execution. These commands may be selected from a group of 10.  Clock
<u>Data Storage</u>	Tape recorder 3000-ft. tape. Record/playback speed ratio 1:4. 4 tracks used as: 1) PCM at 2500 bits/incl 2) Sounder up to 10 KHz 3) VLF up to 20 KHz 4) Reference tone and clock
<u>Antennae</u>	Sounder: crossed dipoles 240 and 62 ft. Telemetry (136 MHz) and command: Turnstile whips Tracking beacon and 137 Mhz beacon: quadraloop 400 MHz telemetry: annular slot
<u>Power</u>	11,136 n-on-p type solar cells: Ni-Cd (Nickel-cadmium) batteries

The most significant difference in the facilities provided by ISIS A and its predecessors in the ionosphere-probing satellite series is in the provision of on-board data storage.

During the initial design stages of Alouette I this was considered impractical. Because Alouette II employs the same spaceframe as Alouette I, there would have been no room for data storage, quite apart from the lack of time available for development. Despite the large number of ground stations available for data collection, however, there are large areas around the world from which data reception is unavailable.

It was decided, therefore, to fill these gaps by data storage facilities within ISIS A, and its specially-developed tape recorder will be capable of storing information simultaneously from all experiments.

Data storage has necessitated other changes in the spacecraft's facilities. The experiments and the tape recorder must be able to be switched on when the spacecraft is out of range of any ground stations. Consequently, a programmer is provided capable of storing five commands as well as the times at which each is to be implemented. Each command may be selected from a list of 10 of those most commonly employed. A clock will make it possible to switch on the tape recorder at any desired time. The actual time at which data is obtained will also be recorded and the clock will be reset.

The telemetry requirement has been altered also as a result of data storage requirements. If the number of data links had remained the same as in the Alouette satellites, data would be gathered from a specific location at the expense of data at the station where the recorded information will be received. An extra link in ISIS A will obviate this shortcoming.

In order to receive all the information stored in the tape recorder during one pass, this additional data link is wide-band - 400 MHz link with a bandwidth of 500 KHz. It will be used as well to transmit the sounder or VLF data in the event of trouble with the wide-band 136 MHz link whose transmitters have been duplicated in the spacecraft.

In the predecessor Canadian satellites, data from experiments other than the sounder or VLF and also house-keeping information are transmitted in continuous form by employing frequency multiplexing. In ISIS A, these data will be time multiplexed using pulse code modulation. This change in the telemetry system should make automatic data reduction simpler at the ground centers concerned.

While the attitude sensing instrumentation will be similar to that on Alouette II, attitude control has been incorporated in ISIS A.

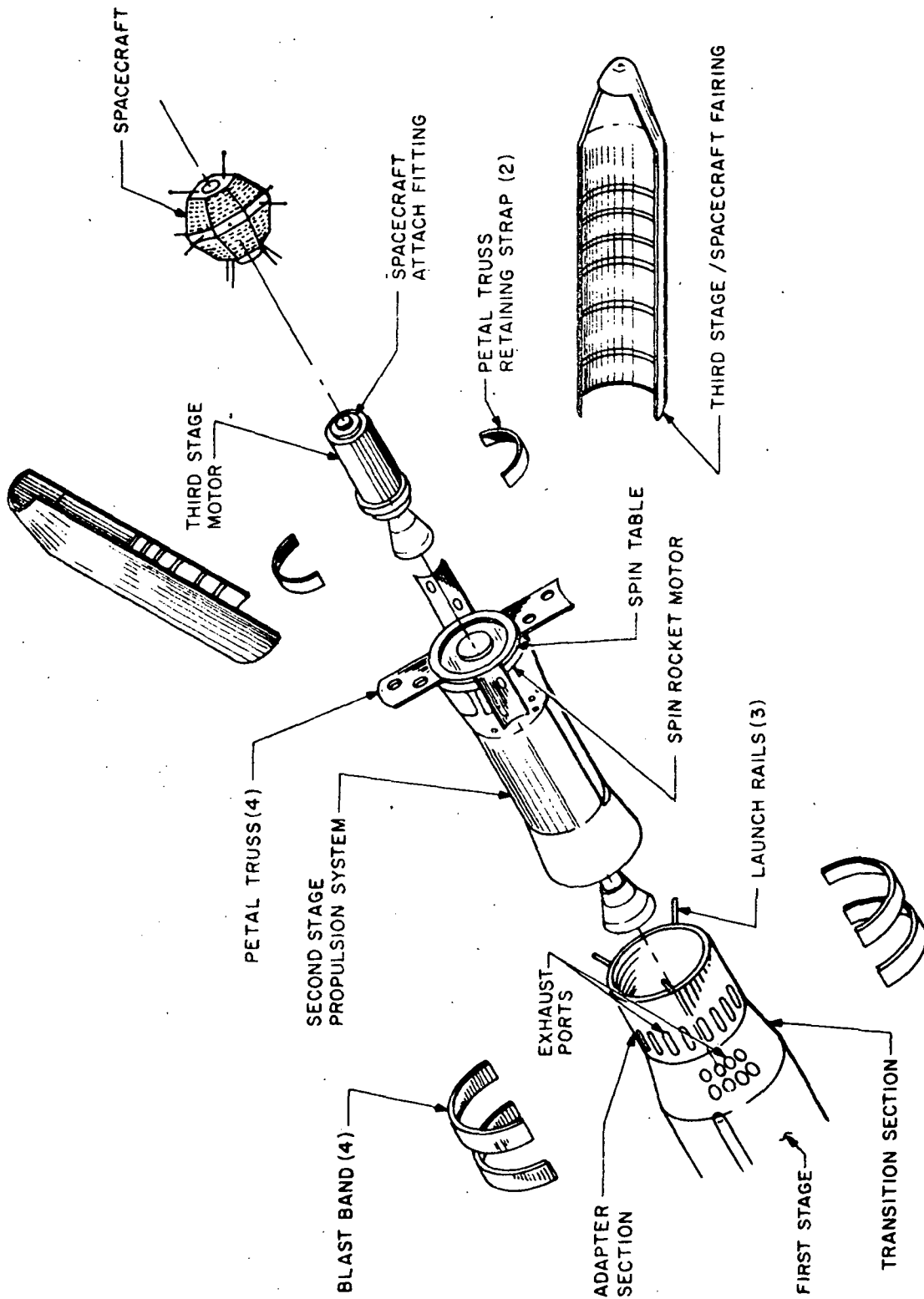
Alouette I has shown marked changes in the attitude of its spin axis and rapid decay in its spin rate. The spin axis attitude changes can be explained by a combination of gravity gradient effects on the long antennas and magnetic movement of the spacecraft - the excessive spin rate decay is due to thermal bending of the antennas. These factors cause the spacecraft's centre of pressure to be displaced from its centre of gravity and solar radiation pressure is then able to exert a decelerating torque. On ISIS A, therefore, spin rate will be controlled by magnetic torquing to within the limits of 1 and 3 rpm while spin axis attitude will also be capable of being modified.

To meet the requirements of ISIS A extra transmitters, more antennas are required. A quadraloop antenna is mounted around the midsection of the spacecraft and an annular slot has been cut in the section which is the top of the spacecraft at launch.

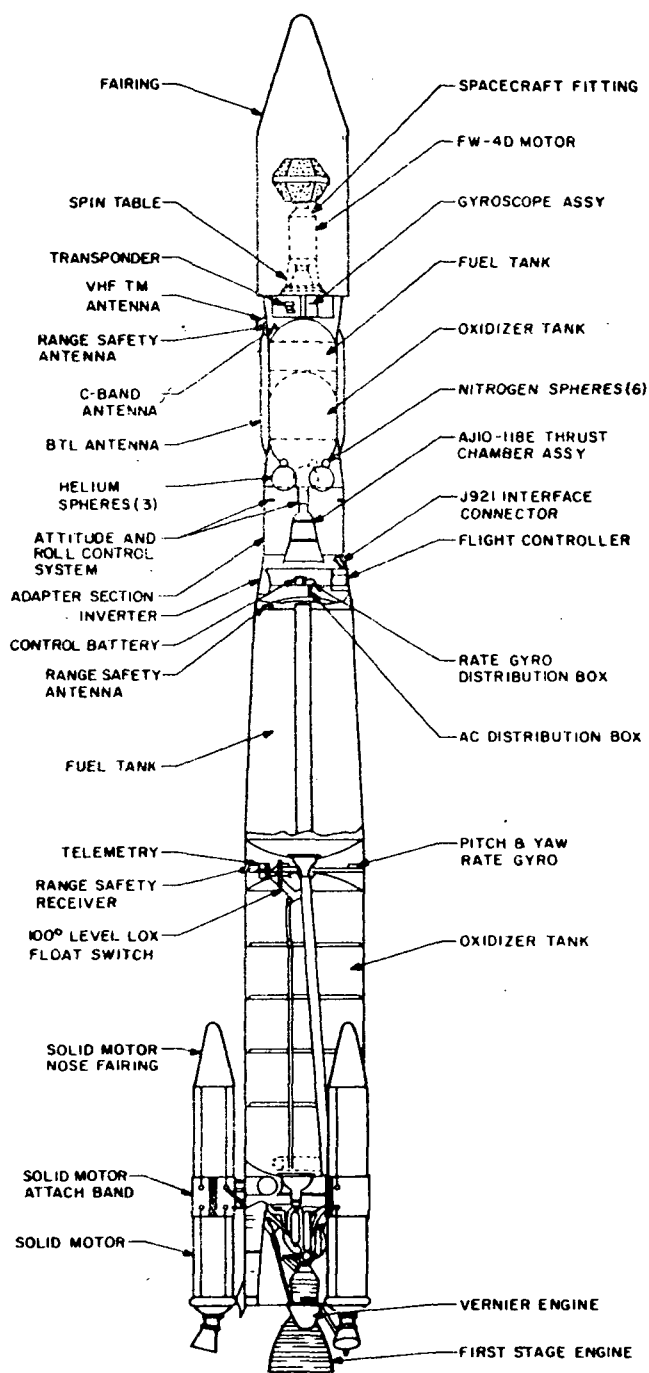
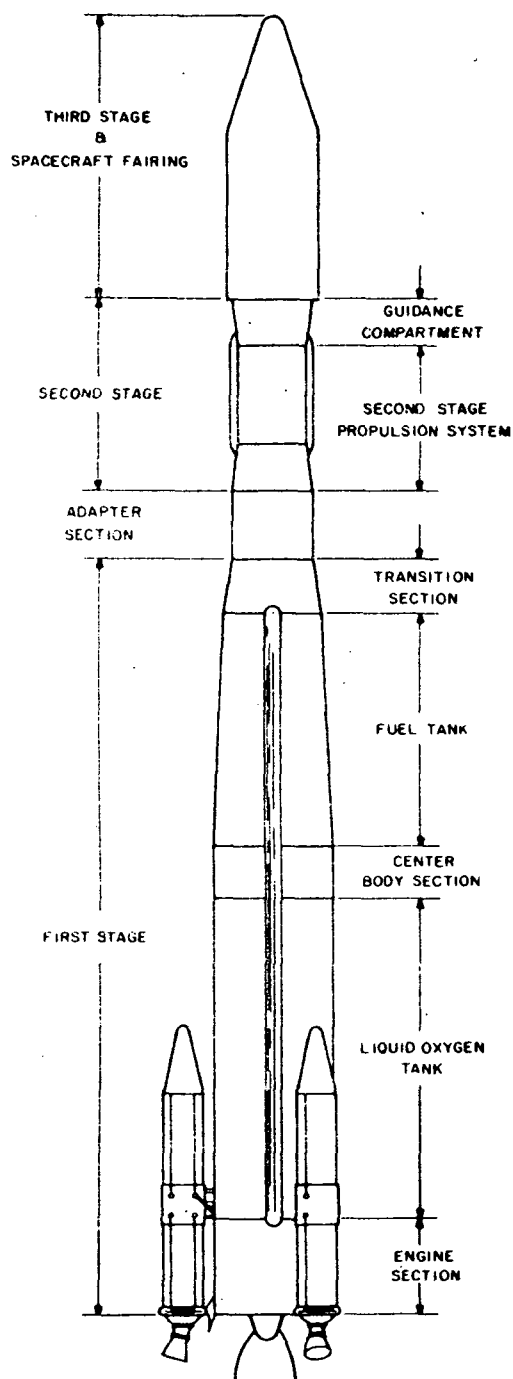
Additional experiments and facilities require increased power supplies. ISIS A's more than 11,000 solar cells will be capable of providing five hours per day of full spacecraft operations under minimum Sun conditions after a year in orbit, providing of course, the known radiation environment does not change.

ISIS A prime contractor is the RCA Victor Co., Ltd., Montreal, Canada, under supervision of the DRTE.





Launch Vehicle/Spacecraft Separation



Improved Delta Launch Vehicle

### DELTA LAUNCH ROCKET

The ISIS A will be launched by NASA's Thrust Augmented Improved Delta rocket. Launch will be from the Western Test Range, Calif. The three-hour ISIS A launch window opens at 1:30 a.m. EST Jan. 30. The initial launch azimuth is 195 degrees.

NASA's Thrust Augmented Improved Delta rocket consists of a thrust-augmented Thor first stage, an enlarged Delta second stage, and the FW-4 third stage.

Delta project management is directed by NASA's Goddard Space Flight Center, Greenbelt, Md. Launch operations are conducted by the Unmanned Launch Operations Directorate, NASA Kennedy Space Center, Fla. The McDonnell/Douglas Corp., Santa Monica, Calif., is Delta prime contractor.'

### Delta Statistics

The three-stage Delta for the ISIS A mission has the following characteristics:

Height: 92 feet (includes shroud)

Maximum Diameter: 8 feet (without attached solids)

Liftoff Weight: about 75 tons

Liftoff Thrust: 270,000 pounds (including strap-on solids)

First Stage (liquid only): Modified Thor, produced by Douglas Aircraft Co., engines produced by Rocketdyne Division of North American Aviation.

Height: 51 feet

Diameter: 8 feet

Weight: approximately 53 tons

Thrust: 172,000 pounds

Burning Time: 2 minutes, 30 seconds

Propellants: RP-1 kerosene is used as the fuel and liquid oxygen (LOX) is utilized as the oxidizer.

Strap-on Solids: Three solid propellant Castor II rockets produced by the Thiokol Chemical Corp.

Height: 25 feet

Diameter: 3 feet

Weight: 30,000 pounds (all three solids)

Thrust: 100,000 pounds (all three solids)

Burning time: 38 seconds

Propellants: solid

Second Stage: Produced by the Douglas Aircraft Co., utilizing the Aerojet-General Corp., AJ-10-118E propulsion system; major contractors for the Auto-pilot system include Minneapolis-Honeywell, Inc., Texas Instruments, Inc., and Electrosolids Corp.

Height: 16 feet

Weight:  $6\frac{1}{2}$  tons

Diameter: 4.7 feet

Thrust: 7,700 pounds

Burning Time: 6 minutes, 26 seconds

Propellants: Liquid-Unsymmetrical Dimethyl Hydrazine (UDMH) for the fuel and Inhibited Red Fuming Nitric Acid (IRFNA) for the oxidizer.

Third Stage: FW-4 developed by the United Technology Corp.

Height: 5 feet, 2 inches

Diameter: 19.6 inches

Weight: about 660 pounds

Thrust: 5,450 pounds

Burning Time: 31 seconds

Propellant: solid

Flight Events

Nominal times for major flight events during the  
ISIS A mission are as follows:

<u>Event</u>	<u>Time From Lift-Off</u>
Strap-on Solids Burnout	43 seconds
Separation of Solids	70 seconds
Main Engine Cut-off	150.7 seconds
Second Stage Ignition	156.5 seconds
Shroud Jettison	162.7 seconds
Second Stage Cut-off	510 seconds
Third Stage Ignition	734.7 seconds
Third Stage Burnout	765.5 seconds
Spacecraft Separations	879.7 seconds

**ISIS-A TEAM**

**Experimenters**

G. L. Nelms and C. E. Petrie Defense Research Telecommunications Establishment (DRTE)	<u>Swept Frequency Sounder</u>
W. Calvert and T. VanZandt, ESSA Research Laboratories, Environmental Science Services Administration, C. E. Petrie and G. L. Nelms, DRTE	<u>Fixed Frequency Sounder</u>
R. E. Barrington, DRTE	<u>VLF Receiver</u>
I. B. McDiarmid and J. R. Burrows National Research Council	<u>Energetic Particle Detector</u>
W. J. Heikkila, Graduate Research Center of the Southwest	<u>Soft Particle Spectrometer</u>
R. S. Narcisi, Air Force Cambridge Research Laboratories	<u>Ion Mass Spectrometer</u>
L. H. Brace and J. A. Findlay, NASA/Goddard Space Flight Center	<u>Cylindrical Electrostatic Probe</u>
R. C. Sagalyn and M. Smiddy, Air Force Cambridge Research Laboratories	<u>Spherical Electrostatic Analyzer</u>
P. A. Forysth, E. A. Forsyth, G. F. Lyon, E. H. Tull, Univ- ersity of Western Ontario	<u>136/137 Mc/s Beacon</u>
T. R. Hartz, DRTE	<u>Cosmic Noise</u>

Program Participants

Defense Research Telecommunications Establishment

F. T. Davies	Director-General
C. D. Florida	Project Director
Dr. C. A. Franklin	Chief Engineer
Harold R. Raine	Project Officer
Norman A. Harrison	Mechanical Project Engineer

NASA Headquarters

J. L. Mitchell	Director, Physics & Astronomy Programs
T. L. Fischetti	Program Manager, Geophysical, Observatories
F. W. Gaetano	Associate Program Manager
E. R. Schmerling	Program Scientist
I. T. Gillam	Delta Program Manager

Goddard Space Flight Center

Dr. John F. Clark	Director, Goddard Space Flight Center
E. Dale Nelson	ISIS-A Project Manager
John E. Jackson	ISIS-A Project Scientist
William R. Schindler	Delta Project Manager

Kennedy Space Center

Dr. Kurt H. Debus

Director, KSC

Robert H. Gray

Director, Unmanned Launch Operations  
KSC

Henry R. Van Goey

Manager, Unmanned Launch Operations  
Western Test Range

Wilmer C. Thacker

Chief, Delta Operations, KSC/WTR

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